Safe Handling of Mercury

Introduction

Mercury comes in several forms that have different hazards. This Supplement will help users to handle and dispose of them safely.

Spills of metallic mercury are hazardous if they are ignored or improperly addressed, and spill cleanup becomes a major nuisance. This Supplement gives guidance about how to avoid or limit the size of metallic mercury spills and how to clean them up.

Toxicity and Hazards

Mercury is a liquid metal that slowly evaporates at room temperature. Mercury forms salts by reacting with many other nonmetallic elements and also forms organomercury compounds with carbon. Some mercury salts and organomercury compounds can irritate the skin and can also pass through intact skin. While all forms of mercury are toxic, the metallic form is the least toxic. Material Safety Data Sheets for several forms of mercury are included in Appendix A of this Supplement.

Metallic mercury vapor is readily absorbed from inhaled air and can also pass through intact skin. Metallic mercury is then carried by the blood to the central nervous system where it is oxidized. The oxidation product produces injury. Persons heavily exposed to metallic mercury will develop worsening tremors of the hands, shyness, insomnia, and emotional instability. (As an aside, the Mad Hatter of *Alice in Wonderland* is a caricature of the then well-known disease of hat makers who cured felt in pools of mercury.)

Mercury salts attack the kidneys.

Organomercury attacks the nervous system, causing tremors, impaired vision and hearing, and paralysis. The effects from exposures to excessive levels of airborne mercury or skin contact with mercury compounds may not become noticeable for months or years. Metallic mercury vapors can reach very high levels when the liquid is heated, though, and people can be exposed to levels that will cause adverse effects almost immediately if workplace controls are inadequate.

Fulminate of mercury is an explosive. Mercury(II) oxide is special because it is an oxidizer.

The maximum average concentration of mercury metal vapor that personnel are allowed to be exposed to throughout an entire shift is 0.05 mg of vapor per cubic meter of air. The equivalent figures for aromatic organic compounds, mercury salts, and alkyl organic compounds are respectively 0.1, 0.1, and 0.01 mg/m^3.

Problems Peculiar to Metallic Mercury

Metallic mercury is usually easy to work with under normal conditions, but becomes a serious problem when spilled. Some reasons for this are:

- Mercury is dense (specific gravity ~13.5); large drops shatter into numerous small droplets that can move at great speed across large distances.
- The droplets and vapors tend to congregate in crevices. Porous materials can become contaminated and may be too difficult to decontaminate.
- Mercury amalgamates with metals. Metal objects soiled by spilled mercury often cannot be decontaminated and must be discarded. Metal contaminated with mercury is also weaker.
- Microorganisms convert metallic mercury to organomercury compounds that are even more hazardous. Mercury is a significant ecological problem.

Many of the following precautions are intended to eliminate unnecessary exposures, minimize the likelihood of spills, or to confine and make them easy to clean up.

Small spills of metallic mercury can usually be cleaned up safely by the employees involved, if the employees have been trained in advance. Hazards Control will provide this training on request. Materials for the cleanup of mercury spills are available from Stores. (See Appendix B.) Report all spills of mercury to your Safety Team Leader. If the spill is too large to clean up safely or if employees have been injured or contaminated, call the LLNL emergency number 2-7333 (or 3-5333 at Site 300).

Controls

General

• Contact Hazards Control when planning any operation involving mercury.

• Safety procedures prepared according to Chapter 2 of the LLNL *Health and Safety Manual* are required for operations where mercury or mercury compounds will be heated. Use enclosure, exhaust ventilation, or other controls to keep excessive levels of mercury out of the breathing air and the environment.

• Personnel who use mercury compounds, metallic mercury, or equipment that contains more than one cm^3 of metallic mercury (other than in thermometers) must be trained about the hazards and how to handle mercury safely, according to the guidelines in *Health and Safety Manual* Supplement 1.02, "Health Hazard Communication." Obtain the Material Safety Data Sheets (MSDSs) for the mercury compounds you use and follow the handling precautions given in them. Contact your Hazards Control Field Team to obtain MSDSs or other information about handling mercury safely.

Metallic Mercury

Work Practices

• Avoid using mercury whenever possible. For example, use alternative instruments to measure temperature or pressure that have no mercury.

• Prohibit eating, drinking, smoking, and the storage of food, drinks, smoking materials, and cosmetics where mercury is stored or used.

• Avoid skin contact. Use rubber or plastic gloves when handling mercury, but avoid using disposable gloves, which can tear and allow mercury to lodge under the fingernails.

• Wash hands and face after handling mercury and before lunch, breaks, or leaving work.

• Groups using breakable or open equipment that contains more than 10 cm^3 of mercury need to receive training in how to use mercury vacuums. (Call your Hazards Control Field Team to see if this training is needed and to arrange for it.)

Facilities and Equipment

• Mercury spill control kits are needed in places where more than 1 cm^3 of mercury is used (other than in thermometers and sphygmomanometers). Contact your Hazards Control Field Team for guidance in procuring spill kits and instructions in how to use them.

• Assure that areas where mercury is used have adequate ventilation or vapor containment systems. Call your Hazards Control Field Team for assistance.

• Avoid working with mercury on surfaces with cracks (such as tile seams, spaces between wood boards, baseboards, wall coving, gaps between table legs and floors), crevices, and hard-to-reach spaces. Also avoid porous surfaces (such as carpets, wood, and crinkle-texture paint), and false floors. Concrete floors sealed with epoxy or another surface that also has few crevices are preferred.

• Whenever possible, place equipment containing mercury in a catch basin. The catch basin needs to be made of smooth impervious materials (such as plastic or smooth-finish paint), must be large enough to contain the greatest amount of mercury that could spill, have sufficient dimensions to catch mercury droplets escaping from any plausible direction, and must have lips (steep lips will be more effective than gentle rises in trapping spilled mercury).

• Protect large or complex systems with mercury by placing catch pans under each major component.

• Avoid storing or handling mercury near sinks. Spilled mercury could run into the sink, lodge in the trap, ruin the pipe by amalgamating with and weakening the metal, and be released to the environment or a retention tank system designed only for dilute solutions in rinse water.

• Felt mats (LLNL Stock Class 5330) or horse hair mats (LLNL Cat. No. 8135-53247) can be put on seamless plastic sheets laid in catch pans to catch the droplets from mercury spills. The droplets can then be collected by simply wrapping up the plastic with the mat still inside and disposing of it as mercury waste. See Appendix C for disposal procedures.

• Mercury manometers should have removable plastic shields, mercury traps, and blow-out valves.

Storage

• Minimize the amount of mercury stored and used.

• Containers of mercury need to be made of either impact-resistant material or be put in sturdy holding containers. Glass bottles should be put in tight metal containers. All mercury containers must be labelled "*WARNING: VAPOR HARMFUL AT ROOM TEMPERATURE—MAY BE FATAL IF HEATED IN THE OPEN—Do Not Breathe Vapor—Use With Adequate Ventilation—Avoid Skin Contact*" (LLNL Cat. No. 4280-45123-4).

• Keep mercury containers closed when they are not in use.

• Avoid cutting cartons that contain plastic bottles filled with mercury. (The cutting could tear open a plastic bottle and cause a mercury spill.)

• Store mercury in a cool place.

• Do not store mercury near acetylene, ammonia, boron phosphodiiodide, chlorine dioxide, methyl azide, and ground sodium carbide, as these create explosive mixtures with mercury.

Shipping

• Mercury containers that are too heavy for easy handling may be moved over short distances on carts (within a lab or, at most, different labs in the same building).

• Mercury must be in sealed, labelled, shatter-resistant containers when being moved over short distances (at most, between labs in nearby buildings).

• Use double containers when shipping mercury over longer distances. The outer containers should be filled with packing such as horse hair (LLNL Cat. No. 8135-53247), Kimpak (LLNL Cat. No. 8135-27940-3), or bubble pack (LLNL Cat. No. 8135-65918). Sweeping compounds (LLNL Stock Class 7930) can be used as packing materials if oil or other contaminants are also present. The inner container should be shatter resistant and needs to be sealed and labelled.

• Objects with mercury in them can be shipped on-site "as is" *if* they have shatter-proof casings and are durably sealed and labelled. Objects that do not meet these specifications, and all objects being shipped off-site that have mercury in them, need to be labelled, sealed, and put in shatter-proof containers that are filled with packing inside, sealed, and labelled outside or the equivalent (double-containment). Equipment or objects containing mercury that are out of use are hazardous waste and need to be prepared for transport and disposal through Hazardous Waste Management (see Appendix C).

Spills

• When spills occur, block off places where drops and droplets of spilled mercury are visible by using any available tape, rope, etc. Post signs (made with any available materials) advising *"MERCURY SPILL—Keep Out!"* Avoid walking on or touching surfaces contaminated with mercury. Promptly notify your Hazards Control Field Team and inform them if other forms of contamination (such as radioactivity) are or may also be present. The Field Team will survey the area and adjust the boundaries of the blocked-off area as needed. They can also loan a mercury vacuum and other cleaning supplies and also furnish technical support (see Appendix B).

Disposal

• Waste mercury is considered hazardous and must be disposed of through Hazardous Waste Management (see Appendix C). Call the Hazards Control Field Team for assistance.

First Aid

• Wash mercury from eyes or skin at a safety shower or eye-wash station. Remove contaminated clothing and put it in a plastic bag (LLNL will provide replacement underclothes and coveralls and reimburse an employee for lost clothing). Confine water runoff as well as you can with available supplies (water can be directed to drains *if* they are hooked up to retention tanks). Report to Health Services.

• Call your Hazards Control Field Team if mercury-contaminated water enters a retention tank. They will notify the Environmental Protection Department so that arrangements can be made to have this water analyzed and properly disposed of.

• Use a mercury vapor sniffer to check the space under the fingernails if mercury might be there. Use soap, water, and a scrub brush to remove it until the sniffer shows it is gone. Do not use the solutions that come with mercury-cleanup sponges or powders—some are corrosive!

• Mercury metal is most hazardous when inhaled or if it remains on the skin for long. It is not highly hazardous when ingested. Other forms of mercury can rapidly penetrate through intact skin or can irritate the skin. Inform Health Services what form of mercury is involved.

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Appendix A
Occupational Health Guidelines and Chemical Data Sheets for Mercury and Mercury Compounds Used at LLNL

This appendix contains material safety information for metal and alkyl mercury compounds (from the National Institute for Occupational Safety and Health, and Occupational Safety and Health Administration Occupational Health G*uidelines for Chemical Hazards*), mercury(II) oxide (based on data supplied by Hach and N.I. Sax, ed., *Dangerous Properties of Industrial Materials*), mercury(II) chloride (based on L.W. Keith and D.B. Walters, *Compendium of Safety Data Sheets for Research and Industrial Chemicals* and *Dangerous Properties of Industrial Materials*), and fulminate of mercury (based on data from *Poisindex* and *Dangerous Properties of Industrial Materials*).

Appendix B
Spill Cleanup

- Small items can be decontaminated by Hazardous Waste Management. Call ext. 3-1196 to see if they can help. Package the items and ship them as described in the main text.
- Small spills of mercury or its compounds can be cleaned up by the involved employees if they have received special training from Hazards Control. Call ext. 2-7333 (or 3-5333 at Site 300) if a spill is too large to clean up, if people have been contaminated, or if people have been injured.
- Use protective clothing sufficient to keep mercury droplets off your clothing and skin. Always use plastic or rubber gloves (never use disposable gloves, which can tear and allow mercury to lodge under the fingernails). Use disposable foot covers whenever mercury is on the floor. Suitable protective gear is listed in Table A-1. Estimate the gear in Table A-1 that will be right for the job; overestimate if in doubt.

Table A-1. Mercury spill cleanup protective gear.

Item	Catalog Number
Impervious gloves, rubber	8415-4567 (Sizes 8 - 9)
Impervious gloves, rubber lined	8415-2811-3 & 8415-4886 (Sizes S, M, L & XL)
Impervious gloves, plastic	8415-4667 10 (Left & Right Hand, Sizes M & L)
Shoe Covers, disposable	8489-6699
Booties, heavy soled	8489-4652
Apron, laboratory, large & heavy	8405-5567
Apron, laboratory, small & light	8405-2225
Disposable coveralls without hood (blue)	8415-6610-2 (Sizes M, L, & XL)
Disposable coveralls without hood (white)	8415-6604

Disposable coveralls with hood (white)	5 (Sizes M & L) 8 (Sizes S, M, & L)	Respirator, airline Respirator, cartridge	As above, but with no chlorine limitation. Airline hoses must be "sniffed" for mercury contamination before returning to Respirators or storage location.

Apply from Respirators for most qualified trained users without beards. Use must be approved in advance by Industrial Hygiene. Can be used where there is more than 10 ppm chlorine in air.

- Use the buddy system when using respirators. Watch the color of the end-of-service indicators of the faces of the other person's cartridges. Replace cartridges when the end-of-service indicators change color. Be careful not to drag airline respirator hoses through mercury. Check hoses for contamination with a mercury sniffer before storing them or returning them to Respirators.
- Spread plastic sheets over surfaces that mercury could drop or run onto during spill cleanups. Tape the sides of the sheets to the floor.
- Mercury may lodge in dust, oil, etc., and such materials often need to be removed with the mercury during spill cleanup. Clean the dust and oil as you would normally (detergent or solvent to remove oil or grime, vacuum to remove dust), but use the mercury-

control precautions cited in this Supplement.

- Dip rags in cleaning solutions once—never dip a dirty rag in clean solution, because this will contaminate the solution and the container. Minimize the amount of mercury-contaminated liquid generated during such cleanups, as contaminated liquid wastes are difficult to dispose of.
- Mercury spill kits have hand-powered miniature vacuums or sponges. Use them to clean up spills whenever practical.
- Never sweep mercury-contaminated dirt or blow it off of surfaces with compressed-air nozzles (this spreads contamination). Vacuum it off or seal it in place.
- Flowers of sulfur or "HgX" powder can be used to seal mercury that has entered crevices in place. These do not absorb or neutralize mercury, but they form hard shells around the droplets that seal in the vapor. Mercury can also be sealed into crevices with sealer or caulk. These techniques should be used only when necessary (when removal is prohibitively time consuming or expensive), because the trapped mercury will then be a health hazard for those who will work on the affected surfaces later on. *Notify your Hazards Control Field Team and your Environmental Analyst, before sealing any mercury in place.*
- Vacuuming (with a vacuum cleaner built for mercury-spill cleanup) is the best method for cleaning up large amounts of mercury. Each Hazards Control Field Team has a mercury-control vacuum. Avoid using regular vacuum cleaners, since the mercury amalgamates with copper in the motor; the motor exhaust then dumps high concentrations of mercury vapor into the air, and the machine must be discarded because it is too dangerous to use and cannot be decontaminated. Check the mercury vacuum's exhaust with a mercury sniffer before using it and remove as much mercury as possible from the inside of the vacuum after using it—too much residual mercury can ruin the mercury absorber.
- Resisorb is useful in eliminating mercury vapors near surfaces, particularly after removing liquid mercury from them.
- Bulky items may be contaminated with mercury. Pack the insides with dry absorbent material if the object has oil on the inside. Try to dismantle large items into pieces that can be bagged and then put into 55-gallon drums (or yellow drums if radioactive contamination is also present). Inform your Hazards Control Field Team if this is not practical.
- Throw used rags, other used cleaning materials, used protective gear, and items of mercury-contaminated gear in plastic bags. Gently squeeze excess air from the plastic bags and seal them. Mops and other large tools used for mercury spill cleanup need to be cut up so they can be bagged and not be reused. Put the sealed bags in lard cans or drums. Always use yellow drums if radioactive contamination is also present. Label the lard cans or drums with hazardous waste labels and fill out a Hazardous Waste Management Requisition Form. Send the completed requisition form to Hazardous Waste Management for approval and assignment of pickup date. Place the sealed, labelled containers in an approved waste accumulation area for temporary storage.
- The Hazards Control Field Team needs to conduct a clearance survey before removing the access barriers. The spill area cannot be returned to normal use until this survey is completed.

Appendix C
Mercury Waste Disposal

- Waste mercury is considered a hazardous waste and must be disposed of through Hazardous Waste Management. Those who generate mercury waste must request waste-disposal services from Hazardous Waste Management. Two different requisition forms are available for this purpose: one for hazardous waste (LL 5344-B) and one for radioactive waste (LL 5344). A requisition form is required for each waste package submitted for transfer to Hazardous Waste Management.
- Mercury-contaminated items can be overpacked into 55-gallon drums available from Hazardous Waste Management. Gray 17C drums are used for nonradioactive material and yellow 17H drums are used for radioactive material. Seven-gallon lard cans are available from Bulk Issue (LLNL Catalog No. 8110-27825) for packaging smaller items. All drums or lard cans must be lined with polyethylene liners. Metallic mercury may be disposed of through Hazardous Waste Management in leak-proof containers overpacked in a sealed outer container. The void space between containers should be filled with an absorbent material.
- After completing the Hazardous Waste Management Requisition Form, a Health and Safety Technician must sign the form, indicating that the material has been inspected and is safe to transport to Hazardous Waste Management. The completed requisition form is then sent to Hazardous Waste Management (L-620) for processing.
- For additional information regarding the disposal of hazardous waste, contact your Environmental Analyst.

Miscellaneous Wastes

- Fluorescent tubes do not contain enough mercury to be considered hazardous waste unless (a) 20 or more tubes are being disposed of together or (b) people routinely handle broken tubes in only one area (a person forced to dispose of one or two fluorescent

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- Use protective clothing sufficient to keep mercury droplets off your clothing and skin. Always use plastic or rubber gloves (never use disposable gloves, which can tear and allow mercury to lodge under the fingernails). Use disposable foot covers whenever mercury is on the floor. Suitable protective gear is listed in Table A-1. Estimate the gear in Table A-1 that will be right for the job; overestimate if in doubt.

Table A-1. Mercury spill cleanup protective gear.

Item	Catalog Number
Impervious gloves, rubber	8415-41576-7 (Sizes 8-9)
Impervious gloves, rubber lined	8415-28311-3 & 8415-49806 (Sizes S, M, L & XL)
Impervious gloves, plastic	8415-64607-10 (Left & Right Hand, Sizes M & L)
Shoe Covers, disposable	8430-68199
Booties, heavy soled	8430-45692
Apron, laboratory, large & heavy	8405-50697
Apron, laboratory, small & light	8405-28235
Disposable coveralls without hood (blue)	8415-66810-2 (Sizes M, L, & XL)
Disposable coveralls without hood (white)	8415-66604-5 (Sizes M,& L)
Disposable coveralls with hood (white)	8415-66606-8 (Sizes S, M, & L)
Respirator, cartridge	Available from Respirators for medically qualified trained users without beards. Use must be approved in advance by Industrial Hygienist. Cannot be used where there is more than 10 ppm chlorine in air.
Respirator, airline	As above, but with no chlorine limitation. Airline hoses must be “sniffed” for mercury contamination before returning to Respirators or storage location.

- Use the buddy system when using respirators. Watch the color of the end-of-service indicators of the faces of the other person’s cartridges. Replace cartridges when the end-of-service indicators change color. Be careful not to drag airline respirator hoses through mercury. Check hoses for contamination with a mercury sniffer before storing them or returning them to Respirators.
- Spread plastic sheets over surfaces that mercury could drop or run onto during spill cleanups. Tape the sides of the sheets to the floor.
- Mercury may lodge in dust, oil, etc., and such materials often need to be removed with the mercury during spill cleanup. Clean the dust and oil as you would normally (detergent or solvent to remove oil or grime, vacuum to remove dust), but use the mercury-control precautions cited in this Supplement.
- Dip rags in cleaning solutions once—never dip a dirty rag in clean solution, because this will contaminate the solution and the container. Minimize the amount of mercury-contaminated liquid generated during such cleanups, as contaminated liquid wastes are difficult to dispose of.

- Mercury spill kits have hand-powered miniature vacuums or sponges. Use them to clean up spills whenever practical.
- Never sweep mercury-contaminated dirt or blow it off of surfaces with compressed-air nozzles (this spreads contamination). Vacuum it off or seal it in place.
- Flowers of sulfur or "HgX" powder can be used to seal mercury that has entered crevices in place. These do not absorb or neutralize mercury, but they form hard shells around the droplets that seal in the vapor. Mercury can also be sealed into crevices with sealer or caulk. These techniques should be used only when necessary (when removal is prohibitively time consuming or expensive), because the trapped mercury will then be a health hazard for those who will work on the affected surfaces later on. *Notify your Hazards Control Field Team and your Environmental Analyst, before sealing any mercury in place.*
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- Resisorb is useful in eliminating mercury vapors near surfaces, particularly after removing liquid mercury from them.
- Bulky items may be contaminated with mercury. Pack the insides with dry absorbent material if the object has oil on the inside. Try to dismantle large items into pieces that can be bagged and then put into 55-gallon drums (or yellow drums if radioactive contamination is also present). Inform your Hazards Control Field Team if this is not practical.
- Throw used rags, other used cleaning materials, used protective gear, and items of mercury-contaminated gear in plastic bags. Gently squeeze excess air from the plastic bags and seal them. Mops and other large tools used for mercury spill cleanup need to be cut up so they can be bagged and not be reused. Put the sealed bags in lard cans or drums. Always use yellow drums if radioactive contamination is also present. Label the lard cans or drums with hazardous waste labels and fill out a Hazardous Waste Management Requisition Form. Send the completed requisition form to Hazardous Waste Management for approval and assignment of pickup date. Place the sealed, labelled containers in an approved waste accumulation area for temporary storage.
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• Mercury-contaminated items can be overpacked into 55-gallon drums available from Hazardous Waste Management. Gray 17C drums are used for nonradioactive material and yellow 17H drums are used for radioactive material. Seven-gallon lard cans are available from Bulk Issue (LLNL Catalog No. 8110-27825) for packaging smaller items. All drums or lard cans must be lined with polyethylene liners. Metallic mercury may be disposed of through Hazardous Waste Management in leak-proof containers overpacked in a sealed outer container. The void space between containers should be filled with an absorbent material.

• After completing the Hazardous Waste Management Requisition Form, a Health and Safety Technician must sign the form, indicating that the material has been inspected and is safe to transport to Hazardous Waste Management. The completed requisition form is then sent to Hazardous Waste Management (L-620) for processing.

• For additional information regarding the disposal of hazardous waste, contact your Environmental Analyst.

Miscellaneous Wastes

• Fluorescent tubes do not contain enough mercury to be considered hazardous waste unless (a) 20 or more tubes are being disposed of together or (b) people routinely handle broken tubes in only one area (a person forced to dispose of one or two fluorescent tubes does not need to take special precautions other than those needed to avoid being cut by the glass). Places where fluorescent tubes are routinely broken must be considered to be mercury work areas and be surveyed periodically by Hazards Control. The phosphor powder in these tubes is also not significantly toxic (information on the toxicity of the phosphor dates back to the 1940s, before the use of toxic beryllium phosphors in fluorescent tubes was stopped).

• See Section 9.06 of the LLNL *Health and Safety Manual* for information about disposing of mercury batteries.

• Contact your Hazards Control Field Team for guidance about disposing of other forms of mercury.